Recent Advances in Bayesian Adaptive Assessment of Behavioral Functions and Statistical Modeling of Brain Networks

ABSTRACT:

Conventional psychophysical methods often require large amount of data collection and are very time consuming and impractical for many applications in basic research and clinical settings. To reduce the burden of data collection, we have developed a set of Bayesian adaptive testing procedures by creating optimal experimental designs that provide accurate, precise and efficient estimates of behavioral functions, including the TvC function, d' psychometric function, contrast sensitivity function, sensory memory decay function, reading function, and time course of perceptual sensitivity change. In all cases, the adaptive procedure can reduce the amount of data collection by as much as 80% to 95% without losing precision. For example, the quick CSF method, an adaptive procedure for estimating the contrast sensitivity function (CSF), can provide an accurate assessment of the CSF in 25-50 trials. In the first part of the talk, I will describe the Bayesian adaptive test framework and its applications with animations, simulations and psychophysical validations.

Network models of the brain have led to important findings about how the functional and structural organization of the brain gives rise to cognition. A fundamental challenge in this analysis, however, is that current statistical techniques are not suited to quantifying the operating characteristics of correlation networks: (1) the mathematical properties of the correlation matrix are not fully considered, (2) contemporary methods often require threshold dichotomization of information about connectivity, (3) the influence of brain structure on functional connectivity is not controlled, and (4) univariate rather than multi-variate statistics are used to describe network properties. To address these issues, we develop the correlation Generalized Exponential Random Graph Model (cGERGM) – a statistical network model that uses local processes to capture the emergent structural properties of correlation networks without loss of information. In the second part of the talk, I will describe the cGERGM and its applications to the subnetworks of the brain.